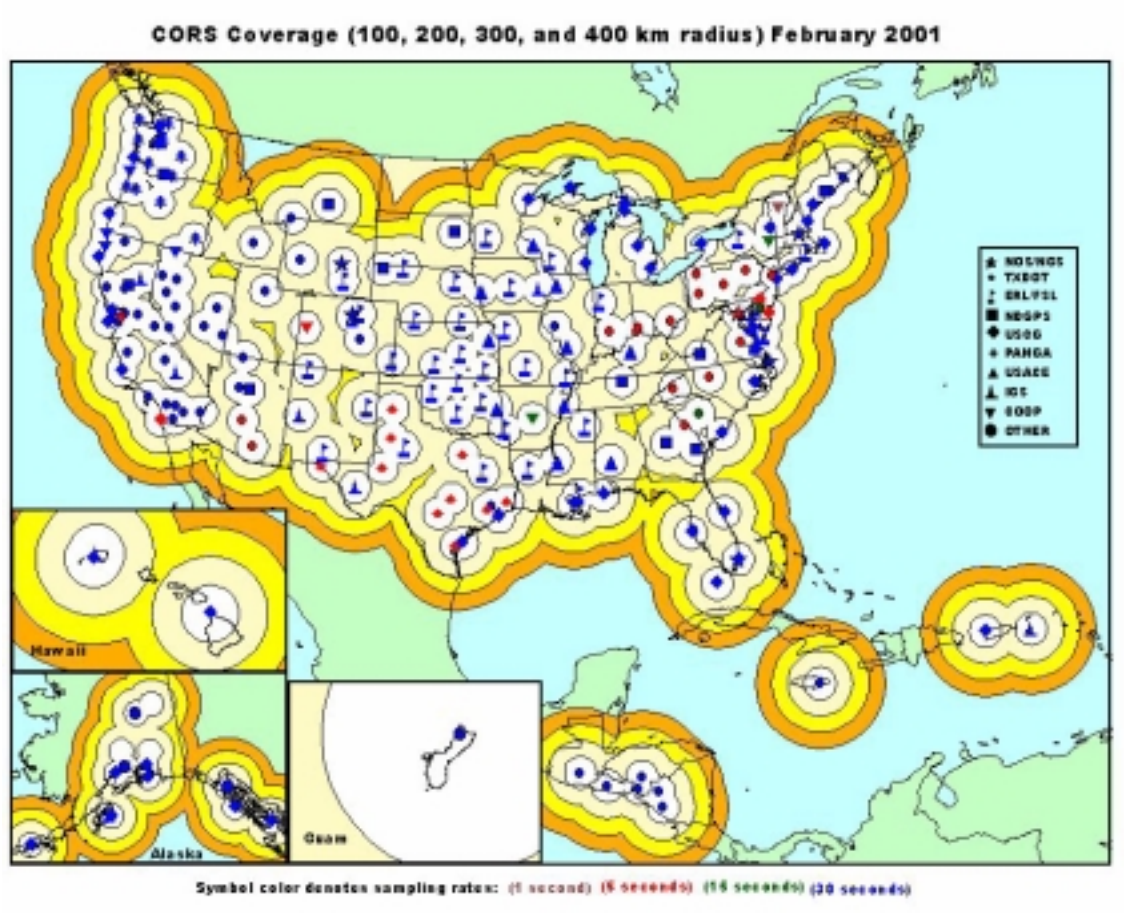
CORS Industry Forum
National Geodetic Survey
National Ocean Service, NOAA

March 26, 2001



FEEDBACK SESSION RESULTS

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CORS Industry Forum
Executive Summary

Program Purpose and Overview

On March 26th, the National Geodetic Survey (NGS), an Office of NOAA's National Ocean Service, sponsored a CORS Industry Forum to provide information about the National and Cooperative CORS (Continuously Operating Reference Station) programs, receive feedback from existing and prospective CORS partners, and promote a dialog to facilitate an appreciation for how CORS can be used to enhance businesses and their respective mission delivery.

Approximately 100 members of the CORS community attended the Forum, 53 of which are current or prospective CORS partners representing institutions other than NGS. A listing of participants may be found in the Appendix of this report. The Forum was structured to share information about the CORS during the morning session and solicit input from non-NGS participants during the afternoon.

The morning briefings by NGS personnel provided information about the CORS including purpose, structure, partners, applications, data, accessibility, technical innovations, coordinates/orbits and models. The PowerPoint file for these presentations may be viewed/downloaded from the web site:

http://www.ngs.noaa.gov/CORS/

Click on "General Information" and then on "Presentations".

The afternoon session was structured to solicit input from non-NGS participants on what aspects of the National and Cooperative CORS programs are working well; what aspects are not working well and to delineate outstanding needs of NGS and its CORS partners. Participants were asked to select one of the following subjects as a focus area for discussion:

- Applications/outreach/technology transfer
- Data Formats
- Reference station operation/Cooperative CORS

- Technical Innovations
- Coordinates, orbits and models for accurate positioning.

Highlights of Feedback Session

The afternoon input session was designed to promote interaction by small groups and to collect and document input on the CORS. The process promoted balanced participation and input by all non-NGS participants. NGS personnel acted as recorders and documented participant input on flip charts for each of the following 4 questions:

1. What aspects of the National and Cooperative CORS systems are working well?
2. What aspects of the National and Cooperative CORS systems are not working well?
3. What do you need from NGS and its CORS partners to support accurate positioning?
4. How is CORS information used in typical surveying, GIS, and other activities?

Tables were assigned different topics and were asked to offer priorities (top 5) for each of the 4 questions. The following summary highlights those themes that cut across all table responses and may be viewed as consistent messages to NGS about the CORS and its effectiveness and usability.

What's Working Well?

The first question was, "What aspects of the National and Cooperative CORS systems are working well"? Participants offered the following positive messages about the National and Cooperative CORS:

~ The CORS network is user friendly.
~ Internet accessibility is experienced well.
~ The CORS is experienced as a truly cooperative model.
~ NGS' customer responsiveness and commitment to service is quite apparent.
~ NGS is committed to the users and the taxpayers.

~ The CORS network has great expansion potential.
~ OPUS is highly reliable.

What's Not Working Well?

The second question was, "What aspects of the National and Cooperative CORS systems are not working well"? Participant responses clustered around the following messages:

~ There is great need for network densification, however funding is highly inadequate.
~ There are inadequate standards and specifications as well as instructive supporting information.
~ There is a need for a seamless integration of the National and Cooperative CORS.
~ There is inadequate coordination with manufacturers on planned changes.
~ The Blue Book is highly outdated and outmoded.
~ NGS needs to improve data formats, sampling rates, and the timeliness of data dissemination.

Needs of the CORS and NGS

Forum attendees were asked, "What do you need from NGS and its partners to support accurate positioning"? Responses to the questions are centered around the following themes:

~ Improve and standardize formats.
~ Develop and disseminate standards and specifications.
~ Let's secure resources together or show us where to go to get them!
~ Enhance the system infrastructure including bandwidth and capacity.
~ Provide leadership for consensus building among system partners.
~ Increase communications, education and outreach on what's available and how to use it.
~ Enhance "real time" data availability.
~ Densify the network.
~ Provide a seamless integration of the National and

Cooperative CORS.

Uses of CORS Information

The last question asked, “How is CORS information useful? What are the new potential uses for CORS information”? Multiple tables offered the traditional and important current uses of CORS information such as positioning, navigation applications and deformation applications. Some new potential applications included real-time positioning, precision farming, emergency management, flood management, weather prediction, and shipping (keel location).

Conclusion

Charlie Challstrom, Director of NGS, offered closing remarks by highlighting the important messages NGS received in the afternoon as well as acknowledging the important partnerships that help to make the system what it is today. He committed to follow-up actions in response to participant inputs and welcomed ongoing input and dialog beyond the Forum.

Forum Evaluations

Attendees provided written evaluations, which offered the following assessment of the Forum:

~ 88% of the participants rated the morning briefings a 4 or higher (5 highest rating). The comments ranged from informative and interesting to desire for a level of greater depth.

~ 85% of the participants rated the afternoon feedback session with a 4 or greater. Comments ranged from good exchange of ideas and interesting to too structured.

~ Overall, folks seemed pleased with the ability to have an exchange of ideas and meet their peers. More information is desirable and an interest in similar future forums was highlighted.

Feedback Session Materials

Table Assignments

Table Number	Topic
1, 2, and 3	Reference station operation/Cooperative CORS
4	Coordinates, orbits and models for accurate positioning
5	Data formats
7	Technical Innovations
8	Applications/outreach/technology transfer

Table Members

Table 1. Peter Borbas, Brian Dollman-Jersey, Don D'Onofrio, Jim Naismith, Gary Nolan, Ron Ramsey, Gary Schenk, and Malkiat Singh.

Table 2. Curt Clabaugh, Roy Dokka, Eduardo Falcon, Mark Huber, Tim LeSeige, Mike McGuinness, and James Stowell.

Table 3. Al Dalmida, Bob Lemoine, Kim Lochhead, Andy Semenchuk, and Mike Zmuda.

Table 4. Emerson Bornman, Earl Burkholder, Swen Ericson, Larry Hothem, Peter Lazio, Eric Orndorff, and Nathan Pugh.

Table 5. Steve Briggs, Mark Bryant, Carey Noll, and Dave Stowers.

Table 7. Marc Cheves, Gordon Garrard, Elwyn McLachlan, Jim Stanton, Bill Strange, and Mike Willis.

Table 8. James Arnold, Jay Chamberlain, Bill Ethridge, David Martin, Rudy Persaud, and Milo Robinson.

Questions

1. What aspects of the National and Cooperative CORS systems are working well?
2. What aspects of the National and Cooperative CORS systems are not working well?
3. What do you need from NGS and its CORS partners to support accurate positioning?
4. How is CORS information used in typical surveying, GIS, and other activities?

Recurring Themes

What's Working Well

- Network ease of use – user friendly.
- Internet accessibility.
- Truly cooperative model.
- NGS customer responsiveness and service commitment.
- NGS out there for users and taxpayers.
- CORS network expansion potential.
- OPUS reliability.

What's Not Working Well

- Lack of resources ($$) – network densification is needed.
- Inadequate standards and specifications along with supporting information.
- Need for seamless integration of the National and Cooperative CORS.
    - ~ Software (manufacturers)
- Inadequate coordination with manufacturers on changes.
- Improve formats, sampling rates and dissemination timeliness.

Needs of NGS and CORS

- Improved and standardized formats.
- Specifications
- Standards
- Resources ($$)

- Seamless data and data transfer.
- Enhanced infrastructure, bandwidth, capacity.
- Leadership/coordination with all partners.
- Communications, outreach, education on what's available and how to use it.
    - ~ Detail when available with examples, etc.
- Advances/enhancements to "real-time" data availability.
- Network densification.
- Seamless integration of National and Cooperative CORS

Uses of CORS

- Real-time positioning
- Navigation applications
- Airborne applications
- New potential applications – precision farming, shipping (keel location), flood management, emergency management, weather prediction.

Top Issues

Tables 1, 2, 3: Reference Station Operation/Cooperative CORS

What's Working Well – Table 1

1. Efforts to establish standards for a CORS station and for data exchange.
2. Accessibility via Internet is increasingly easy to use.
3. Likes ability to work cooperatively with NGS, but keep control of station.
4. Ability to monitor and post stability of stations.
5. Reliability of National CORS and quality.
6. Dissemination of GPS related information is very good (e.g., CORS newsletter).

What's Working Well – Table 2

1. OPUS – reliable, robust response.
2. NGS response – customer service.
3. COOP CORS concept.
4. Management
5. User-friendly web page.

What's Working Well – Table 3

1. Will be installing 12 cooperative CORS stations in Michigan.
   - ~ Keep local control of stations.
2. Freely accessible data.
3. Ease of access (UFCORS utility).
4. Flexibility of being COOP CORS.
5. Provides partnership with industry.

What's Not Working – Table 1

1. Specifications for building a COOP CORS network.
2. Need specifications for observation sessions and data processing using CORS.
3. Funding for COOP CORS.
4. Different feedback from different NGS personnel on what NGS accepts.
5. Inadequate information on emerging technologies.

What's Not Working – Table 2

1. Concise standards.
   - ~ Formats – RINEX, sampling rate, coordinate confusion.
   - ~ Position quality approved by NGS.
2. Seamless integration of National and COOP CORS.
3. Budgetary process.
4. Density of network.
5. Real-time corrections – why not?

What's Not Working – Table 3

1. Incompatibility between CORS NAD and HARN NAD coordinates.
2. Lack of standards.
3. Need web forum for discussing problems – chat rooms.
4. COOP CORS not linked to National CORS positioning.
5. Cost sharing between CORS and COOP CORS.

Needs of NGS and CORS – Table 1

1. Education for user on how to get more accurate positioning – workshops/user oriented publications.
2. "Tap" into other agencies for funding or tell us where we might go for funding.
3. Better specifications for use of CORS.
4. Leadership for consensus building among CORS partners.
5. Seamless data sets.
6. Densification of network.

Needs of NGS and CORS – Table 2

1. Formats and standards as per question #2.
2. Densification
3. Seamless integration of National CORS and COOP CORS.
4. Turn key site certification program.
5. Instrument certification.

Needs of NGS and CORS – Table 3

1. COOP funding.
2. Infrastructure for data transfer.
3. Future stations outside of U.S.
4. Coordination between NGS, IGS and other partners (international).
5. Technology modernization with private industry – keep up with modern technology.

Uses of CORS Information – Table 1

1. Real-time geodetic applications.
2. Accurate cost effective base system for uniform data development and analysis (GIS).
3. Provide cm-level accuracy over longer baselines.
4. Airborne GPS controlled photogrammetry.
5. GPS controlled hydrographic and tidal data.

Uses of CORS Information – Table 2

1. Large structure deformation monitoring.
2. Feature identification.
    - ~ Subsidence monitoring.
    - ~ Cadastral geo referencing.
    - ~ Lateral earth strain (crustal motion monitoring).
3. RTK, DGPS
4. Connection to NSRS.
5. Airborne GPS mapping (engineering grade).

Uses of CORS Information – Table 3

1. Real-time needs and high precision corrections.
2. Control – one less receiver on project per CORS station.
   ~ Geodetic control
3. Plate tectonics.
4. Data validation (via OPUS).
5. GIS for virtual base station.

Table 4: Coordinates, orbits and models for accurate positioning

What's Working Well

1. Timeliness of orbit products – ultra-rapid orbits with 3 hours latency.
2. UFCORS distribution of data.
3. GEIOD 99.
4. Organization of data products.
5. Responsiveness to customer needs.

What's Not Working

1. Confusion of antenna (ARP's).
   ~ Standardized antenna list online (lack of list).
2. Publish standard deviations for coordinates in all three components.
3. Working with manufacturers/software.
4. Significant digits inconsistent on data sheets (recovery).
5. Unmatched coordinate systems – ITRF vs. NAD.

Needs of NGS and CORS

1. Publishing standard deviations for coordinate values.
2. Better notices of available products – graphical representation.
3. Cooperation between manufacturers and NGS.
4. Publish best available coordinates on all stations.
5. Graphical representation of antenna ARP's.

Uses of CORS Information

1. Real-time network data distribution.
2. CORS replaces the need for ground monuments.
3. Real-time data (orbits) distribution.
4. Unify state-wide spatial reference systems.
5. OPUS/CORS easier to reference state plane coordinates.

Table 5: Data Formats

What's Working Well

1. RINEX is working fine/accepted as standard – documented.
2. Coordinates kept up on CD-ROM geographic interface is a plus.

What's Not Working

1. Changing formats should be given to manufacturers ASAP.
2. Blue book format is outdated – philosophy and format.
3. Some inertia in format changes (multiplier in version 2.2, etc.). Readers need to handle versions 2.0, 2.1, then 2.2.
4. Bluebook in contract specifications is misunderstood – does not guarantee accuracy.
5. Redesign of data formats could be done in academia.

Needs of NGS and CORS

1. Continued NGS participation in defining formats and transport for real-time data, seamless archive.
2. 72 hour upper limit more reasonable for OPUS (CT-CORS).
3. Real-time data availability (1 second data).
4. OPUS users should be able to send PKZIP, GZIP, Hatanaka, etc. files.
5. UFCORS should allow current day in menu for date/time.

Uses of CORS Information

1. Weather prediction.
2. Real-time precision farming.
3. Surveyors need to understand datum issues between CORS and HARN stations (quantify difference).
4. Keel positioning using ellipsoid heights.
5. Real time construction (machine control).

Table 7: Technical Innovations

What's Working Well

1. User-friendly CORS providing access to data for users.
2. OPUS is successful, especially for positioning RTK base stations.
3. OPUS evaluation by Canada received positively.
4. CORS latency is acceptable for science, maybe not real time.
5. Cooperative CORS is a good initiative.

What's Not Working

1. 5 second data rate desired. Don't want interpolated values.
2. Is OPUS turnaround time realistic (20 minutes)?
   ~ Sensitivity tests on RADOMEs.
3. Characterization of the effects of interpolating RINEX data.
4. Desire all hourly data files, not daily data files.
5. More efficient data compression.

Needs of NGS and CORS

1. Real time – need Iono, tropo, etc. correctors.
2. Explanation of OPUS uncertainties. Define monumentation and multi-path.
3. Good education – everyone needs to be on the same system.
4. User education to differentiate L1/L2 phase center vs. monument, especially for RTK operations.
5. More stations closer together.

Table 8: Applications/Outreach/Technology Transfer

What's Working Well

1. Ease of use.
2. Consistency of reference frame between NGS and NDGPS.
3. "Certifies" position and stability for beacon (NDGPS).
4. Open to expansion and use by participation of other groups.
5. Evidence of healthy growth – system is expanding.
6. Evidence of interest by state DOT groups.

What's Not Working

1. Outreach – not well known to lay community.
2. For new GPS users, describe practical applications.
3. CORS fails to be recognized as substantial de facto component of the National Spatial Data Infrastructure (NSDI).
4. Confusion regarding adjustments, CORS vs. HARN especially heights – ref. frame issues.
5. CORS too "virtual" for use as legal control.
    - ~ Not guaranteed as defendable.
    - ~ No historical basis.

Needs of NGS and CORS

1. Support navigation applications real time more robust.
2. More CORS sites – complete coverage plus redundancy.
3. Support orthometric heights.
4. Ease data transfer (e.g., precipitable H2O). Latency as data moves from site through web to Forecast Systems Lab (FSL), hourly update insufficient for H2O, not available from FSL.
5. Support open GIS consortium mapping data transfer formats (XML).

Uses of CORS Information

1. Need better height information for flood management.
2. Support real time emergency management – mapping applications.
3. GPS III support in future GPS design.
4. Redundancy and back up for mapping projects (e.g., if beacon fails, use CORS to post process).
5. Post processed, carrier and code, high accuracy.

Complete List Of Brainstorm Materials

What's Working Well

Reference Station Operation/Cooperative CORS (Tables 1 – 3)

Table 1

1. Accessibility via Internet is increasingly easy to use. ***(7 votes)***
2. NGS CORS group responsiveness is very good – proactive.
3. Ability to monitor and post stability of stations. ***(5 votes)***
4. Reliability of National CORS and quality. ***(2 votes)***
5. Dissemination of GPS related information is very good (e.g., CORS newsletter). ***(2 votes)***
6. Efforts to establish standards for a CORS station and for data exchange. ***(9 votes)***
7. OPUS and user friendliness. ***(1 vote)***
8. Education efforts.
9. Support multiple coordinate systems (local and otherwise).
10. Likes ability to work cooperatively with NGS, but keep control of station. ***(6 votes)***

Table 2

1. User-friendly web page. ***(1 vote)***
2. Management ***(3 votes)***
3. COOP CORS concept. ***(5 votes)***
4. NGS response time.
5. Open to public contributions. ***(1 vote)***
6. OPUS – reliable, robust response. ***(5 votes)***
7. NGS response – customer service. ***(5 votes)***

Table 3

1. Good initiative for plate tectonics.
2. Good near and real time data.
3. Good location (roof of building) for CORS station to act as reference station.
4. Will be installing 12 Cooperative CORS stations in Michigan.
   ~ Keep local control of stations.
5. Freely accessible data. ***(5 votes)***

6. Ease of access (UFCORS utility). ***(2 votes)***
7. Flexibility of being COOP CORS. ***(2 votes)***
8. NGS support of COOP CORS. ***(1 vote)***
9. Good check or validation of data collected (OPUS). ***(1 vote)***
10. COOP CORS can give choice of more modern equipment.
11. Good for resource availability. ***(1 vote)***
12. Readily available data with choice of collection rate. ***(1 vote)***
13. Provides partnership with industry. ***(2 votes)***
14. COOP entity can set their own coordinate system.

Additions

1. We saw two questions – National and Cooperative.
2. Introduction of RINEX format has had tremendous impact.
3. NGS efforts on antenna calibration.

Coordinates, orbits and models for accurate positioning (Table 4)

1. Timeliness of orbit products – ultra-rapid orbits with 3 hours latency. ***(5 votes)***
2. Organization of data products. ***(2 votes)***
3. UFCORS distribution of data. ***(5 votes)***
4. HTDP software velocities. ***(1 vote)***
5. GEOID 99 ***(4 votes)***
6. Monument recovery data sheets. ***(1 vote)***
7. Responsiveness to customer needs. ***(2 votes)***
8. Graphical representation of data time series. ***(1 vote)***

Data Formats (Table 5)

1. RINEX is working fine/accepted as standard – documented.
2. Coordinates kept up on CD-ROM geographic interface is a plus.

Technical Innovations (Table 7)

1. User-friendly CORS providing access to data for users.
2. OPUS is successful, especially for positioning RTK base stations.
3. OPUS evaluation by Canada received positively.
4. CORS latency is acceptable for science, maybe not real time.
5. Cooperative CORS is a good initiative.

Applications/Outreach/Technology Transfer (Table 8)

1. Precipitation H2O information.
2. "Certifies" position and stability for beacon (NDGPS). ***(2 votes)***
3. Potential to support RT GPS positioning.
4. Open to expansion and use by other groups. ***(2 votes)***
5. Evidence of healthy growth – system is expanding. ***(1 vote)***
6. Incorporates advancements (antenna calibration, H2O, monuments).
7. Consistency of reference frame between NGS and NDGPS. ***(4 votes)***
8. Functions as QA/QC tool for surveying.
9. Evidence of interest by state DOT groups. ***(1 vote)***
10. Ease of use. ***(5 votes)***
11. Speed of data access.

What's Not Working Well?

Reference Station Operation/Cooperative CORS (Tables 1 – 3)

Table 1

1. Different feedback from different NGS personnel on what NGS accepts. ***(5 votes)***
2. Consistency in specifications for monuments is poor.
3. Funding for COOP CORS. ***(6 votes)***
4. Specifications for building a COOP CORS network. ***(8 votes)***
5. Automated log sheets would be good.
6. Inadequate information on emerging technologies. ***(5 votes)***
7. Real-time cm level positioning. ***(1 vote)***
8. Need specifications for observation sessions and data processing using CORS. ***(7 votes)***
9. Accessibility of all data elements on web in a user-friendly format. ***(1 vote)***

Table 2

1. Lack of geodetic advisors. ***(1 vote)***
2. Absolute geoid model.
3. Direct involvement of NGS in establishing COOP CORS.
4. Greater confidence in COOP CORS.
5. Lack of standard 1-second sampling rate.
6. Concise standards. ***(7 votes)***
   - ~ Formats – RINEX, sampling rate, coordinate confusion.
   - ~ Position quality approved by NGS.
7. User education. ***(1 vote)***
8. Seamless integration of National and COOP CORS. ***(5 votes)***
9. Budgetary process. ***(3 votes)***
10. Density of network. ***(2 votes)***
11. Real-time corrections – why not? ***(2 votes)***
12. Enforced standards – QA/QC.

Table 3

1. Incompatibility between CORS NAD and HARN NAD. ***(2 votes)***
2. Liability issues. ***(1 vote)***
3. Not enough participation. ***(3 votes)***
4. Lack of standards. ***(2 votes)***
5. Need more workshops for education. ***(1 vote)***
6. Web forum for discussing problems – chat rooms. ***(2 votes)***
7. COOP CORS not linked to National CORS positioning. ***(2 votes)***
8. COOP CORS – higher costs than just sending data to NGS.
9. Cost sharing between CORS and COOP CORS. ***(2 votes)***

Addition

1. Need definition of ITRF and NAD_83 differences.

Coordinates, orbits and models for accurate positioning
(Table 4)

1. Working with manufacturers/software. ***(3 votes)***
2. Update coordinates/velocities. ***(1 vote)***
3. Availability of precise orbits.
4. Unable/don't know how to access precise orbits.
5. Too many coordinates on data sheets.
6. Significant digits inconsistent on data sheets (recovery). ***(3 votes)***
7. Outreach and descriptions of coordinate frames (systems) – consistent? ***(2 votes)***
8. Not using comprehensive 3-D model pertaining to X, Y, Z. ***(1 vote)***
9. Unmatched coordinate systems – ITRF vs. NAD. ***(3 votes)***
10. Confusion of antenna (ARP's). ***(4 votes)***
    - ~ Standardized antenna list online (lack of list).
11. Incomplete data sheets (top missing).
12. Publish standard deviations of all coordinates in all three components. ***(4 votes)***

Data Formats (Table 5)

1. Coast Guard RTCM does not have records 18 and 19.
2. Changing formats should be given to manufacturers ASAP. ***(3 votes)***
3. Some inertia in format changes (multiplier in version 2.2, etc.). Readers need to handle versions 2.0, 2.1, then 2.2. ***(1 vote)***
4. Digital field logs would make Blue Book less painful.
5. Blue Book format is outdated – philosophy and format. ***(3 votes)***
6. Blue Book in contract specifications is misunderstood – does not guarantee accuracy. ***(1 vote)***
7. Redesign format could be done in academia. ***(1 vote)***

Technical Innovations (Table 7)

1. Desire all hourly data files, not daily data files. ***(3 votes)***
2. 5 second data rate desired. Don't want interpolated values. ***(5 votes)***

3. More efficient data compression. ***(3 votes)***
4. Servers too slow. ***(3 votes)***
5. Is OPUS turnaround time realistic (20 minutes)? ***(5 votes)***
    ~ Sensitivity tests on radomes.
6. Characterization of the effects of interpolating RINEX data. ***(5 votes)***
7. "Reverse Doppler" observations corrupt some GIS software.

Applications/Outreach/Technology Transfer (Table 8)

1. Outreach – not well known to lay community. ***(5 votes)***
2. Confusion regarding adjustments, CORS vs. HARN especially heights – reference frame issues. ***(2 votes)***
3. For new GPS users, describe practical applications. ***(3 votes)***
4. CORS fails to be recognized as substantial de facto component of National Spatial Data Infrastructure (NSDI). ***(3 votes)***
5. CORS too "virtual" for use as legal control. ***(1 vote)***
    ~ Not guaranteed as defendable.
    ~ No historical basis.
6. Orthometric heights not supported. ***(1 vote)***

Needs of NGS and CORS

Reference Station Operation/Cooperative CORS (Tables 1 – 3)

Table 1

7. Education for user on how to get more accurate positioning – workshops/user oriented publications. ***(7 votes)***
8. "Tap" into other agencies for funding or tell us where we might go for funding. ***(8 votes)***
9. Better specifications for use of CORS. ***(7 votes)***
10. Leadership for consensus building among CORS partners. ***(6 votes)***
11. Seamless data sets. ***(2 votes)***
12. Densification of network. ***(6 votes)***

Table 2

1. Formats and standards as per question #2. ***(6 votes)***
2. Densification ***(5 votes)***
3. Direct involvement.
4. Money ***(1 vote)***
5. Turn key site certification program. ***(3 votes)***
6. Instrument certification. ***(1 vote)***
7. Seamless integration of National CORS and COOP CORS. ***(5 votes)***
8. Improved communication between inter-government agencies.

Table 3

1. Future stations outside of U.S. ***(2 votes)***
2. COOP funding. ***(3 votes)***
3. Infrastructure for data transfer. ***(2 votes)***
4. NGS – take proactive approach. ***(1 vote)***
5. Can NGS provide data/site criteria to aid in site selection? ***(1 vote)***
6. Coordination between NGS, IGS and other partners (international). ***(2 votes)***
7. Need NGS ideas for station spacing.
8. Can NGS mandate RINEX standards for data? ***(1 vote)***
9. Can OPUS use less than 2 hours of data? ***(1 vote)***
10. Technology modernization with private industry – keep up with modern technology. ***(2 votes)***

Coordinates, orbits and models for accurate positioning
(Table 4)

1. Publishing standard deviations of coordinate values. ***(5 votes)***
2. Publish best available coordinates for all stations. ***(3 votes)***
3. Graphical representation of antenna ARP's. ***(2 votes)***
4. Better notices of available products – graphical representation. ***(4 votes)***
5. Real-time data/orbits distribution.
6. Need single origin of 3-D data. ***(1 vote)***
7. Post quality assurance (orbits). ***(1 vote)***
8. Equations of baseline errors propagation from orbit errors.
9. Stats of provided observables pseudorange data. ***(1 vote)***

10. Cooperation between manufacturers and NGS. ***(4 votes)***

<u>Data Formats</u> (Table 5)

1. Real-time data availability (1 second data). ***(1 vote)***
2. Continued NGS participation in defining formats and transport for real-time data, seamless archive. ***(4 votes)***
3. No hourly NAV files found on web, this is critical (selected sites).
4. 72 hour upper limit more reasonable for OPUS (CT-CORS). ***(2 votes)***
5. OPUS users should be able to send PKZIP, GZIP, Hatanaka, etc. files. ***(1 vote)***
6. UFCORS should allow current day in menu for date/time. ***(1 vote)***
7. COOP CORS position should be checked more often than 90 days.
8. Is there a way to coordinate four character names for new CORS? OPUS needs to know if a new CORS is being established. ***(1 vote)***
9. Better modeling of RADOMEs needed.
10. Make sure RADOME is denoted in the RINEX header and on OPUS output.
11. OPUS could include covariance matrix for averaging solutions.
12. Density of stations is important.
13. Should be a CORS rating system (monumentation, data availability).

<u>Technical Innovations</u> (Table 7)

1. Good education – everyone needs to be on the same system. ***(3 votes)***
2. OPUS should be able to process L1 data only. ***(1 vote)***
3. More stations closer together ***(1 vote)***
4. Real time – need Iono, tropo, etc. correctors. ***(6 votes)***
5. Explanation of OPUS uncertainties. Define monumentation and multi-path. ***(5 votes)***
6. User education to differentiate L1/L2 phase center vs. monument, especially for RTK. ***(2 votes)***
7. Network adjustment with redundant baselines for OPUS.
8. Associate attributes with positions.

Applications/Outreach/Technology Transfer (Table 8)

1. Support open GIS consortium mapping data transfer formats (XML). ***(1 vote)***
2. Support orthometric heights. ***(3 votes)***
3. Ease data transfer (e.g., precipitation H2O). Latency as data moves from site through web to FSL, hourly update insufficient for H2O, not available from FSL. ***(2 votes)***
4. Support navigation applications real time more robust. ***(4 votes)***
5. Support transformations (HARN, CORS, etc.). ***(1 vote)***
   ~ Implement HARN adjustment.
6. More CORS sites – complete coverage plus redundancy. ***(4 votes)***

Uses of CORS Information

Reference Station Operation/Cooperative CORS (Tables 1 – 3)

Table 1

1. Accurate cost effective base system for uniform data development and analysis (GIS). ***(4 votes)***
2. Airborne GPS controlled photogrammetry. ***(2 votes)***
3. GPS controlled hydrographic and tidal data. ***(2 votes)***
4. Real-time geodetic applications. ***(7 votes)***
5. Redundancy of observations provides reliability of positioning. ***(1 vote)***
6. Longer baseline operations at cm level. ***(3 votes)***
7. Support intelligent transportation systems. ***(2 votes)***
8. Velocity studies.
9. NGS leadership in emerging CORS type applications.

Table 2

1. Connection to NSRS. ***(1 vote)***
2. Airborne GPS mapping (engineering grade). ***(1 vote)***
3. RTK, DGPS ***(5 votes)***

4. Large structure monitoring. ***(6 votes)***
5. Feature identification. ***(6 votes)***
    - ~ Subsidence monitoring.
    - ~ Cadastral geo referencing.
    - ~ Lateral earth strain (motion monitoring).
6. Weather prediction.

Table 3

1. Control – one less receiver on project per CORS station. ***(3 votes)***
    - ~ Geodetic control
2. DGPS
3. Data validation (including OPUS). ***(1 vote)***
4. Environmental issues.
5. Photogrammetry/airborne GPS.
6. GIS for virtual base station. ***(1 vote)***
7. Plate tectonics. ***(2 votes)***
8. HARN – CBN re-obs.
9. Zero control network – assumed errorless.
10. Can CORS be tied in with tides, currents, PWV, etc.? ***(1 vote)***
    - ~ Can CORS be used to supplement weather forecasting?
11. Real-time needs and high precision corrections. ***(5 votes)***

Coordinates, orbits and models for accurate positioning
(Table 4)

1. Real-time data (orbits) distribution. ***(4 votes)***
2. Real-time 1-second network data distribution. ***(6 votes)***
3. Less than one second latency of data.
4. Availability of data for scientific applications. ***(1 vote)***
5. CORS replaces the need for ground monuments. ***(5 votes)***
6. Unify state-wide coordinate systems. ***(2 votes)***
7. CORS used to reduce costs. ***(1 vote)***
8. OPUS/CORS easier to reference state plane coordinates. ***(2 votes)***

Data Formats (Table 5)

1. Real-time precision farming. ***(3 votes)***
2. Real time construction (machine control). ***(1 vote)***
3. Weather prediction. ***(4 votes)***
4. Collision avoidance (automobiles).
5. Keel positioning using ellipsoid heights. ***(2 votes)***
6. Surveyors need to understand datum issues between CORS and HARN stations (quantify difference). ***(3 votes)***
7. Single receiver positioning of cell phone towers.

Technical Innovations (Table 7)

1. Means of densifying existing land base system.
2. Using CORS data for differential positioning – L1 only.
3. Tie RTK base stations to NAD83.
4. Use CORS to validate NAD 83 connections.
5. Easy access to NSRS.
6. Scientific applications.
7. CORS eliminates need for base stations in some cases.

Applications/Outreach/Technology Transfer (Table 8)

1. QA/QC of land survey and other projects.
2. Integrated into survey design for speed and economics.
3. Redundancy and back up for mapping projects (e.g., if beacon fails, use CORS to post process). ***(1 vote)***
4. Post processed, carrier and code, high accuracy. ***(1 vote)***
5. Homogenous source for all accuracy grades of GPS data collection.
6. More cost effective data collection, ***(1 vote)***
7. Use FSL weather product to predict need and position snow plows and other highway equipment.
8. Need better height information for flood management. ***(4 votes)***
9. Support real time emergency management – mapping applications. ***(4 votes)***
10. Atmospheric modeling to support nationwide, real-time, sub centimeter system. ***(1 vote)***
11. GPS III support in future GPS design. ***(3 votes)***

Summary of Session Evaluations

NGS
CORS Industry Forum
March 26, 2001
Summary of Session Evaluations

No. of Submissions: (27)

Industry Panel

Overall, my rating of satisfaction with the morning briefings is:

1	**2** (1)	**3** (1)	**4** (11)	**4.5** (2)	**5** (12)
Highly Dissatisfied					**Highly Satisfied**

Why? Comments:

1. Good to meet the NGS people in person. Would have liked a copy of the briefings beforehand to follow and take notes as they were briefed.
2. Didn't hear much from the industry.
3. Open discussions.
4. Good, concise briefing.
5. Informative and interesting.
6. For the caliber of folks that attended, I thought this was fairly basic.

7-27. No comments.

2. Feedback Session

Overall, my rating of satisfaction with the afternoon's feedback session is:

1	**2** (2)	**3** (1)	**4** (12)	**4.5** (1)	**5** (10)
Highly Dissatisfied					**Highly Satisfied**

Why? Comments:

1. Maybe only the top 4 items should be presented next time, so we have more discussion time. Again, it was nice to meet other people working with CORS.
2. Feedback session was too rigid/structured. Needed more opportunity for real brainstorming and idea exchange.
3. Very varied topics. Excellent!
4. Just not sure how effective this process is.
5. Discussions went very well.
6. Great exchange of ideas.
7. Please pursue replacement of blue book format.

8-27. No comments.

3. The highlight of the work session for me was:

Comments:

1. Richard Snay's presentation and interacting with the participants.
2. Meeting NGS people.
3. Feedback session. Many items were discussed and I learned a lot.
4. Good working session.
5. Hearing all the participants in the afternoon.
6. Soler's presentation – excellent overview.
7. Meeting everyone.
8. Information exchange was great.
9. Good exchange of ideas.
10. Round table discussions.
11. Afternoon sessions.
12. Chance to input to NGS.
13. Got to discuss ideas with NGS personnel and other providers.
14. Everything
15. New information learned. Interacting with peers.
16. Hearing concerns of others on how to improve services.
17. Interactions with variety of users and applications.
18. Table discussions of listing topics.

19. The fact that there was several common issues that was a concern of all the tables.
20. Meeting people who have done what I'm about to do.
21. Meeting people with a common interest and goal – opportunity to exchange ideas.
22. The opportunity to meet and interact with other professionals.

23-27. No comments.

4. The biggest disappointment of the work session for me was:

Comments:

1. Not many industry representatives. Morning session could have been held in the break out room – more informal with better interaction.
2. The presentations at the end were too long.
3. No disappointments whatsoever.
4. Too rushed.
5. Not having a more in-depth Q&A on the topic with the NGS folks.
6. Expected more concrete information.
7. Could have used some additional information about relative accuracies during morning session (e.g., baseline accuracy vs. line length).
8. Still could use more sense of direction on new technology.
9. Not learning about the latest or developing technology.

10-27. No comments.

5. Other Comments:

1. Thanks for all the printed reference materials. Also, thanks for the effort you take in trying to meet the needs of the precise positioning community (as usual). It is greatly appreciated.
2. FGDC can help support efforts that facilitate events like

this.

3. Great!!
4. Great forum. Excellent way for NGS to receive input. Keep up the good work.
5. Well done and well planned. Congratulations.
6. Recommend holding these twice a year – in the spring with CGSIC and in the fall in conjunction with ACSM and/or ASPRS conferences.
7. Thanks for a great job.
8. Very worthwhile.
9. Steve Briggs
10. More forums should be held.
11. Well done.
12. Well done.
13. I would have liked more time for discussion on the issues.
14. Thank you!
15. Let's do it again – often.

16-27. No comments.

APPENDIX : FORUM PARTICIPANTS

Participants representing institutions other than NGS

Jim Arnold: Federal Highway Administration, U.S. DOT
J. Peter Borbas: New Jersey Society of Professional Land Surveyors
Emerson E. Bornman, Jr., PLS: Keystone Precision Instruments
Steve Briggs: Trimble Navigation
Mark A. Bryant: Magellan Corporation/Ashtech Precision Products
Earl F. Burkholder; New Mexico State University
Lynne Carbone: Lynne Carbone and Associates
Jay F. Chamberlain: FBI-Physical Surveillance Unit
Marc Cheves: Professional Surveyor Magazine
Curtis Clabaugh: Wyoming Department of Transportation
Michael E Clifton: OAL/U.S. Bureau of the Census
CWO Alvin Dalmida: U.S. Coast Guard Navigation Center
Coskun Demir: General Command of Mapping, Ankara, Turkey
Dr. Roy K. Dokka: Louisiana State University
Kevin Donnalley: U.S. Census Bureau
Don D'onofrio: California Spatial Reference Center
Swen Ericson: MITRE/CAASD
Billy H. Ethridge, Jr., R.P.L.S.: CDS / Muery Services
Eduardo Falcon: TOPCON Positioning Systems
Gordon Garrard: Geodetic Survey of Canada
Joshua Greenfeld: New Jersey Iinstitute of Technology
Valerie L. Hartung: U.S. Bureau of the Census
Larry Hothem: U.S. Geological Survey
Mark W. Huber: U.S. Army Corps of Engineers
Jim Jenigen: Virginia Department of Transportation
Brian Dollman-Jersey P.S.:Michigan Department of Transportation
Peter Lazio: Sidney B. Bowne & Son LLP
Bob LeMoine: Magellan Corporation/Ashtech Precision Products
Timothy E. LeSiege: Maine Department of Transportation
Kim Lochhead: Geodetic Survey of Canada
John Lotz: U.S. Border Patrol
Tom Mackie: Trimble Navigation
Michael D. McGuinness: CDS / Muery Services
Elwyn McLachlan: Trimble Navigation
David Martin: U.S. Customs Service(ENTEK, Inc. SETA contractor)

James M. Naismith: Topcon Positioning Systems
Gary Nolan: BAE SYSTEMS
Carey Noll: NASA Goddard Space Flight Center
Eric M. Orndorff: Herbert, Rowland & Grubic, Inc.
Warren H. Payton: NGS / New Jersey Department of Transportation
Rudy Persaud: Federal Highway Administration, U.S. DOT
Nathan Pugh: Trimble Navigation Ltd
Ronald L. Ramsey: NGS / Michigan Department of Transportation
Milo Robinson: Federal Geodetic Data Committee
LCDR Gary Schenk: U.S. Coast Guard Navigation Center
Andrew W. Semenchuk, P.S.:Michigan Department of Transportation
Malkiat Singh: Geoloc Corp.
James A. Stanton, R.P.L.S.: CDS / Muery Services
James Stowell: Leica Geosystems
David Stowers: Jet Propulsion Laboratory / Caltech
Bill Strange
Mike Willis: Orkand Corporation / US Geological Survey
Mike Zmuda: Virginia Department of Transportation

Participants representing NGS

Gordan Adams
Donna Amoroso
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Miranda Chin
Michael Cline
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Dave Crump
Vicki Davis
Dave Doyle
Nancy Doyle
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Robert Dulaney
Mark Eckl
Joe Evjen
Richard Foote
Steve Frakes
Pamela Fromhertz
Heeyul Han
Don Haw
Kay Heimerling
Steve Hilla
William Kass
George Leigh
Gerry Mader
John Marshall
Edward McKay
Dave McNeice
Dennis Milbert
Gilbert Mitchell
Julie Prusky
Dale Pursell
Dan Roman
Erik Sabowski
Charles Schwarz
Donna Shaw
Renee Shields
Dru Smith
Richard Snay
Tomas Soler
Linda Taylor
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Elizabeth Wade
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Richard Yorczyk
Dave Zilkoski